REVIEW | OPEN ACCESS

Medical Science

The effect of Neural Mobilization on sciatica pain: A systematic review

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To Cite:
Zafarani MA, Almeheyawi RN. The effect of Neural Mobilization on sciatica pain: A systematic review. *Medical Science* 2024; 28: e36ms3330 doi: https://doi.org/10.54905/disssi.v28i147.e36ms3330

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Peer-Review History
Received: 10 February 2024
Reviewed & Revised: 14/February/2024 to 25/April/2024
Accepted: 29 April 2024
Published: 07 May 2024

Peer-review Method
External peer-review was done through double-blind method.

Medical Science
pISSN 2321–7359; eISSN 2321–7367

DISCOVERY SCIENTIFIC SOCIETY

ABSTRACT

Objective: To systematically review and explore the impact of neural mobilization (NM) on pain in patients with sciatica. *Methods:* Five electronic databases were searched. Studies investigating NM in patients with sciatica pain using pain outcome measures mainly to measure potential changes in pain levels. The studies were assessed using the CONSORT statement checklist. *Results:* A total of 1581 articles were identified in the search. After the screening process, eight studies met the inclusion criteria and were included in this review with a total of 368 participants. All the studies measured pain, including the visual analog and numerical pain rating scales. Seven out of eight studies reported that using NM impacted sciatica pain significantly ($p<0.05$) by decreasing the level of pain either separately (n = 3) or by being combined with other interventions, including hot packs, exercise therapy, and electrotherapy (n = 4). *Conclusion:* The studies' results showed consistency in the evidence that supports using NM to address sciatica pain when coupled with other interventions. However, conducting a meta-analysis to measure the effect size of using NM for sciatica pain was not applicable due to the limited number of studies that measured the discrete effect of NM on sciatica pain and the clinical heterogeneity in the methodologies of applying NM in the studies included. Therefore, future studies are advised to measure the discrete effect of NM by recruiting intervention groups who only receive NM.

Keywords: Sciatica pain, radiating low back pain, neural mobilization, nerve mobilization, neurodynamic exercises.

1. INTRODUCTION

Sciatica is a major health issue and a worldwide medical burden (Fairag et al., 2022). In addition, it can lead to significant disability and absence from work (Pais et al., 2013; Ribeiro et al., 2018). The incidence of sciatica increases in people in their forties in both genders (Fairag et al., 2022). Sciatica is a disorder in which a person with an associated lumbosacral nerve root or sciatic nerve distribution experiences pain and/or paresthesia. Sciatica occurs because of sciatic nerve

strain, and causes of sciatica include disc herniation, bone overgrowth (bone spurs) Poutoglidou et al., (2020), the presence of a tumor in rare cases, or nerve damage resulting from a disease such as diabetes mellitus (Gilron et al., 2015). Signs and symptoms include pain that is often exacerbated by flexion of the lumbar spine, twisting, bending, or coughing, loss of sensation or numbness, and weakness with knee flexion (Bharadwaj et al., 2023; Reynoso et al., 2022).

Most mild cases of sciatica can be improved in four to six weeks Valat et al., (2010) with multiple treatment options Khorami et al., (2021), Koes et al., (2007), including pharmacological interventions such as non-steroidal anti-inflammatory drugs, conservative management in the form of exercises, and manual therapy or spinal injection and surgery (Fernandez et al., 2016; Jensen et al., 2019). One of the manual therapy techniques used with neural pathologies, including sciatica pain Miller et al., (2017), is neural mobilization (NM) (Peacock et al., 2023). Recent studies have reported that NM techniques have been used as a method to adjust the radiating pain related to disc disease as they work on improving the mobility of the sciatic nerve, which decreases the mechanosensitivity of the nervous system and increases the compliance of nerve tissues, which results in relieving low back pain (Jeong et al., 2016).

NM and neurodynamic mobilization (NDM) can be used interchangeably. The approach is defined as a set of techniques designed to regain the ability of neural tissues to stretch, restore their flexibility, reduce discomfort, and enhance neural function (Sharma and Sheth, 2018). NM can be applied as a manual technique to target the affected nerve or through exercise (Basson et al., 2015). Several studies have shown the positive therapeutic effects of using NM as a therapeutic intervention in a wide range of cases (Ellis and Hing, 2008). However, to the best of the authors' knowledge, no published study has explored the potential impact of NM on pain systematically among patients with sciatica pain. Therefore, the main aim of this study was to systematically review and explore the impact of NM on pain in patients experiencing sciatica pain.

2. METHOD

Protocol and Registration

This systematic review was submitted and approved through the PROSPERO registry of systematic reviews (registration no. 398964), and it followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

Literature search strategy and study selection

A search to identify randomized controlled trials (RCTs) examining the effect of NM on sciatica pain was conducted in October 2023. Five electronic databases were searched: MEDLINE via PubMed, the Physiotherapy Evidence Database (PEDro), EBSCO, the Allied and Complementary Medicine Database (AMED), and the Web of Science. The search strategy of these databases included terms and keywords related to diagnosis: "sciatica pain" or "intervertebral disc displacement" and "Neural mobilization" using the Boolean operators OR and AND. "Randomized controlled trials" (RCTs) was the key term used to identify the design of the studies.

All search results were reviewed to identify papers that specifically investigated the effect of NM as a treatment method used to manage sciatica pain. No language limitation was applied. The method for selecting relevant studies was consistent with the current suggested guidelines for conducting systematic reviews (Van-Tulder et al., 2003). The following inclusion criteria were adopted to select relevant articles for the review, as reported in (Table 1). All search results were transferred to the Endnote online library. After finding and removing duplicates, one reviewer (MZ) screened all studies systematically by title, and a second reviewer (RA) verified the results. At the abstract stage, the two reviewers (MZ and RA) screened abstracts independently to identify the ones to be included. NM and NDM review articles' reference lists were searched to include relevant studies. Finally, at the full-text stage, the two reviewers (MZ and RA) screened manuscripts independently to identify the relevant manuscripts to be included in this review.

Data extraction

Data from the included manuscripts were extracted (MZ) and checked (RA). The following variables were extracted: Authors, year of publication, study design, age, sex, sample size, the assessment method of NM, NM subtypes, the method of assessing sciatica pain, and the inclusion of a study was decided by consensus between the principal investigator (MZ) and the co-author (RA). Missing data were reported as not reported (NR).

Table 1 Study inclusion criteria.

No.	Criteria	Description
1	Study design	Randomized controlled trials.
2	Study participants	Subjects 18 years old or older, male, and female, diagnosed clinically with sciatica pain or any other conditions diagnosed with the same symptoms of sciatica, such as lumber radiating pain or lumber radiculopathy.
3	Outcome measurements	Studies that reported pain rating scales include visual analogue scale (VAS), numerical rating scale (NRS), and other measurement scales for disability or function including Oswestry disability index (ODI), range of motion (ROM), etc.
4	Study results	Results provided changes in pain of sciatica with neural mobilization.

Methodological Quality Assessment

The methodological quality of all RCTs included was assessed using the Consolidated Standards of Reporting Trials (CONSORT) 2010 statement. The CONSORT statement was conceptualized to help ascertain the standardization and reproducibility of RCTs. The CONSORT statement consists of a 25-item checklist that provides the author with a clear frame of the essential items to be included when constructing and presenting an RCT. Therefore, the CONSORT statement Cuschieri, (2019) has been used as a measure of the methodological quality of the studies reported in this systematic review. Included studies assessed using CONSORT checklist by giving each item 2 = Yes, 1 = No, 0 = Not reported. Therefore, the scores of the included studies ranged from 0 – 50.

3. RESULTS

Following the implementation of the search strategy outlined, a mesh search yielded 1581 articles, of which 205 were duplicate publications (Figure 1), leaving 1376 articles for consideration at the title stage. Screening at the title stage excluded 11299 of these articles, leaving some 77 articles eligible for the abstract stage. Screening at the abstract stage excluded 40 of these articles, leaving 37 eligible for the full-text stage and excluding 32 articles. A total of five articles matching the eligibility criteria were added at the full-text stage. Three articles were found during a manual search and added, resulting in eight articles to be included in this review.

Studies and participants' characteristics

The studies included were published between 2016 and 2022 (Table 2). All eight studies were RCTs. The eight studies included a total of 325 participants. The sample sizes ranged from 20 participants to 80 participants Zainab et al., (2022), with a mean sample size of 36 participants (Morsi et al., 2021). Seven studies included a control population Zainab et al., (2022), Morsi et al., (2021), Adnan et al., (2022), Alshami et al., (2021), Alatawi, (2019), Plaza-Manzano et al., (2020) with sample sizes ranging from 20 participants to 77 participants Zainab et al., (2022) and a mean control sample size of 36 participants. One study recruited an NM intervention group only, with a sample size of 44 participants (Yamin et al., 2016). Four studies included both genders Zainab et al., (2022), Morsi et al., (2021), Adnan et al., (2022), Yamin et al., (2016), while one study was limited to female participants and two studies failed to report gender characteristics (Alatawi, 2019; Zainab et al., 2022).

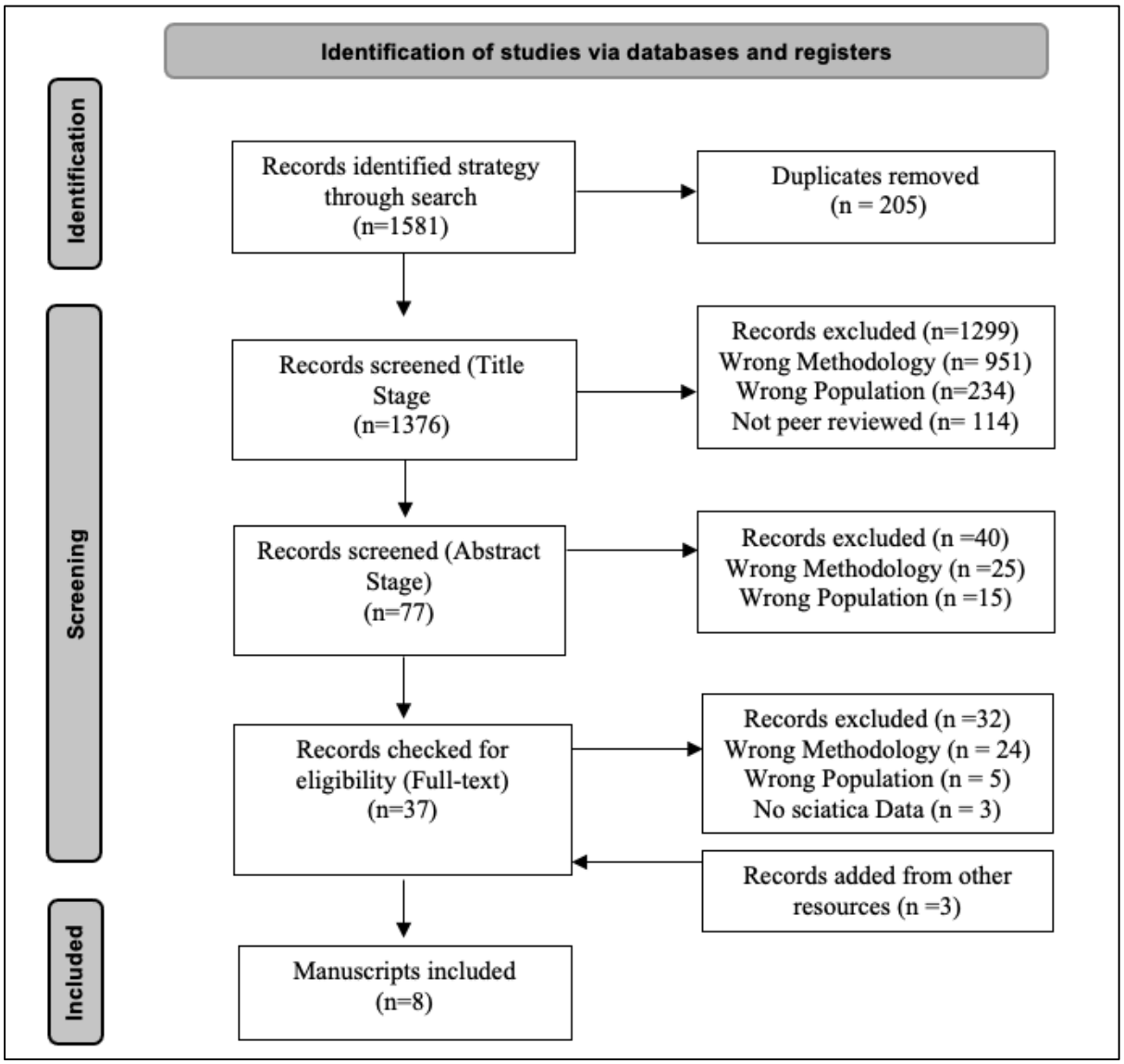

Figure 1 PRISMA flow chart diagram of the systematic review process

Table 2 Study and participants' characteristics

No.	Author	Year of publication	Country	Subjects' subgroups	No. of subjects (Men/ Women)	Age (years)	BMI (kg/m2)
1	Alatawi	2019	Saudi Arabia	Group1: NM + LSE + RESWT	N=15 (NR)	52.27±14.30	22.89±3.84
				Group2: LSE+RESWT	N=15 (NR)	54.87±14.53	23.86±3.26
2	Adnan et al.,	2022	Pakistan	Group1: NDM+ conventional treatment	N=16 (5/11)	38.81±9.94	NR
				Group2:	N=16 (5/11)	38.81±9.94	NR

				Mulligan bent leg raise+ conventional treatment			
3	Alshami et al.,	2021	Saudi Arabia	Group1: Slider NM +TENS	N=17 (17/0)	36.6±8.1	28.2±5.6
				Group2: Tensioner + TENS	N=17 (17/0)	33.5±8.7	28.2±6.1
				Group3: TENS only	N=17 (17/0)	40.2±9.5	27.1±3.8
4	Jeong et al.,	2017	Korea	Group1: NM	N=10 (0/10)	45.87±6.94	23.40 ± 2.67
				Group2: Lower back segment stabilization exercises	N=10 (0/10)	45.93±5.66	23.44 ± 2.38
5	Plaza-Manzano et al.,	2020	Spain	Group1: NM+ motor control exercises	N=16 (8/8)	47.0±80	NR
				Group 2: Motor control exercises only	N=16 (8/8)	45.5±6.0	NR
6	Morsi et al.,	2021	Egypt	Group1: Slider NDM technique	N=12 (5/7)	35.83±7.18	26.83±3.71
				Group2: Tensioner NDM technique	N=12 (5/7)	32.92±7.33	26.42±1.93
				Group3: Stretching exercise	N=12 (4/8)	34.92±6.46	27.92±2.75
7	Yamin et al.,	2016	Pakistan	NDM only	N=44 (22/22)	41.89 ±9.4	NR
8	Zainab et al.,	2022	Pakistan	Group1: Sciatic nerve mobilization + routine physical therapy treatment	N=40 (NR)	39.42±7.62	NR
				Group2: Hot pack +back strengthening exercises +	N=37 (NR)	38.13±8.03	NR

				abdominal bracing exercises			

Abbreviations: BMI =Body Mass Index, NM =Neural mobilization, NR =not reported, TENS =Transcutaneous electrical nerve stimulation. LSE= lumbar stabilization exercise and RESWT =Radial Extracorporeal Shock Wave Therapy.

In terms of age, the mean age of the study participants was 40 years Alshami et al., (2021), Yamin et al., (2016) ranging from 18 years Zainab et al., (2022), Adnan et al., (2022), Plaza-Manzano et al., (2020) to 65 years (Yamin et al., 2016). In terms of body mass index (BMI), four studies reported (Morsi et al., 2021; Alshami et al., 2021; Alatawi, 2019). The mean BMI of the study participants was 26.83.2 kg/m2 ranging from 22.89 kg/m2 Alatawi, (2019), to 28.2 kg/m2 (Alshami et al., 2021). The studies evaluated and diagnosed sciatica using different methods. One study confirmed sciatica by consultation with an orthopedic surgeon or neurosurgeon Adnan et al., (2022), two studies diagnosed sciatica by Magnetic Resonance Imaging Morsi et al., (2021), Plaza-Manzano et al., (2020), and five studies used special tests and the self-reporting of a sciatica diagnosis (Zainab et al., 2022; Alshami et al., 2021; Alatawi, 2019; Yamin et al., 2016).

In terms of interventions, three studies used NM separately in one group Morsi et al., (2021), Yamin et al., (2016), while five studies combined NM with other therapeutic modalities including hot packs and exercise therapy including strengthening exercises, lumbar stabilization exercises, motor control exercises, stretching exercises, and electrotherapy including LASER, radial extracorporeal shock wave therapy (RESWT) and transcutaneous electrical nerve stimulation (TENS) (Zainab et al., 2022; Adnan et al., 2022; Alshami et al., 2021; Alatawi, 2019; Plaza-Manzano et al., 2020).

Assessment of the quality of the studies

Using the CONSORT statement checklist that consists of 25 main items, one of the studies included Zainab et al., (2022) was rated as being of poor quality (17/50) while six studies Morsi et al., (2021), Adnan et al., (2022), Alshami et al., (2021), Alatawi, (2019), Yamin et al., (2016) were of moderate quality (scores ranged from 21–26), and one study Plaza-Manzano et al., (2020) was of higher quality (39/50). Interestingly, none of the studies reported blinding processes or methods, and only one study defined pre-specified primary and secondary outcome measures completely (Zainab et al., 2022). However, only one study reported registration, the extant protocol, and funding information (Plaza-Manzano et al., 2020). The quality assessment of the studies are included in (Table 3).

Table 3 Assessment of study quality using the CONSORT 2018 checklist

	Alatawi	Adnan et al.,	Alshami et al.,	Jeong et al.,	Plaza-Manzano et al.,	Morsi et al.,	Yamin et al.,	Zainab et al.,
1	◉	◉	◉	◉	○	◉	◉	●
2	◉	●	●	○	○	○	●	●
3	◉	○	○	●	○	●	○	○
4	○	○	○	●	○	○	○	●
5	●	●	○	○	○	●	●	●
6	◉	◉	◉	◉	◉	◉	◉	○
7	●	○	●	●	○	●	●	●
8	●	●	○	●	○	●	◉	●
9	●	○	●	○	○	●	◉	●
10	●	●	○	●	●	●	●	○
11	◉	◉	◉	◉	◉	◉	◉	◉
12	○	●	●	●	●	●	●	○

13	○	○	○	●	○	●	○	○
14	●	○	●	○	●	●	●	◘
15	○	●	◘	○	○	○	●	◘
16	◘	●	◘	○	○	○	○	●
17	●	○	●	○	○	○	●	●
18	○	○	◘	○	○	○	◘	○
19	○	●	◘	●	●	○	●	○
20	●	○	○	●	○	○	○	●
21	●	●	●	●	◘	○	○	●
22	○	●	◘	◘	○	○	○	●
23	●	◘	●	●	○	◘	◘	●
24	●	●	◘	◘	○	●	●	●
25	◘	◘	◘	◘	○	◘	◘	●

○=Yes 2 scores, ◘= No 1 score, ●=Not Reported 0 score

Outcome measures

In terms of the outcome measures used to report changes in sciatica pain cases, all the studies evaluated sciatic pain as a primary outcome measure using either the visual analog scale (VAS) in four studies Morsi et al., (2021), Alshami et al., (2021), Yamin et al., (2016), or the numeric pain rating scale (NPRS) in four studies (Zainab et al., 2022; Adnan et al., 2022; Alatawi, 2019; Yamin et al., 2016). Other secondary outcome measures were used to evaluate disability using the Oswestry disability index (ODI) (n = 2), the Modified Oswestry Disability Index (MODI) (n = 1), the Modified Oswestry Disability Questionnaire (MODQ) (n = 1), and the Roland–Morris Disability Questionnaire (RMDQ) (n = 1).

Range of motion (ROM) was evaluated in six studies as lumbar flexion Alatawi, (2019), hip flexion and knee extension Alshami et al., (2021), ankle dorsiflexion Morsi et al., (2021), Straight Leg Raise (SLR) (Zainab et al., 2022; Adnan et al., 2022; Plaza-Manzano et al., 2020). Two additional outcome measures were used in one study Plaza-Manzano et al., (2020) that measured neuropathic symptoms using the Self-Report Leeds Assessment of Neuropathic Symptoms and Signs (S-LANSS) pain scale and pressure pain sensitivity using pressure pain thresholds (PPTs). The pain outcome measures and other outcome measures are reported with results in (Tables 4 and 5).

Table 4 Pain outcome measures used to evaluate the impact of NM on Sciatica pain.

No.	Author	Outcome Measures	Intervention	Results			
				Pre-intervention	Post-intervention	Mean difference	P Value
1	Alatawi	NPRS	Group1: NM +LSE +RESWT	6.47± 1.06	1.80±0.67	4.67	0.000
			Group2: LSE + RESWT	6.20± 0.78	2.87±0.83	3.33	0.000
2	Adnan et al.,	NPRS	Group1: NDM + Conventional treatment	6.0	2.0	NR	<0.001
			Group2: Mulligan bent leg raise+ Conventional treatment	7.0	2.5	NR	<0.001
3	Alshami et al.,	VAS	Group1: Slider NM +TENS	5.1	2.6	2.4	< 0.050
			Group2: Tensioner + TENS	5.1	2.1	3.0	<0 .050
			Group3: TENS only	5.6	4.7	1.0	< 0.050
4	Jeong et al.,	VAS	Group1: NM	5.20 ± 1.27	2.07 ± 0.45	-	<0.001
			Group2: Lower back segment	5.00 ± 1.07	3.93 ± 1.06	-	<0.001

			stabilization exercises				
5	Plaza-Manzano et al.,	VAS	Group1: NM+ motor control exercises	5.9 ± 1.4	2.5 ± 0.8	NR	NR
			Group 2: Motor control exercises only	6.0 ± 1.4	3.4 ± 0.9	NR	NR
6	Morsi et al.,	VAS	Group1: Slider NDM technique	NR	NR	NR	<0.001
			Group2: Tensioner NDM technique	NR	NR	NR	<0.001
			Group3: Stretching exercise	NR	NR	NR	<0.001
7	Yamin et al.,	NPRS	NM only	6.95 ± 1.18	1.86 ± 2.03	NR	<0.05
8	Zainab et al.,	NPRS	Group1: Sciatic nerve mobilization + routine physical therapy treatment	4.30±1.43	1.12± .99	NR	<0.05
			Group2: Hot pack +back strengthening exercises + abdominal bracing exercises	5.16±1.23	2.02±1.36	NR	<0.05

Abbreviations: VAS= Visual analogue scale, NPRS= Numeric Pain Rating scale, NM =Neural mobilization, TENS =Transcutaneous electrical nerve stimulation. LSE =Lumbar stabilization exercise, and RESWT =Radial Extracorporeal Shock Wave Therapy, NDM=Neurodynamic Mobilization.

Table 5 Other outcome measures used to evaluate the impact of NM on Sciatica pain.

No.	Author	Outcome Measures	Intervention	Results			
				Pre-intervention	Post-intervention	Mean difference	P-value
1	Alatawi	Lumbar FROM (degrees)	Group1: NM +LSE +RESWT	2.87±1.13	7.12±1.51	4.25	0.000
			Group2: LSE + RESWT	2.93±0.99	4.19±1.05	1.25	0.012
		MODQ	Group1: NM +LSE +RESWT	43.71±3.16	26.67±3.30	14.05	0.000
			Group2: LSE + RESWT	44.66±4.58	39.20±2.82	5.46	0.002
2	Adnan et al.,	ODI	Group1: NDM+ Conventional treatment	38.81±11.36	22.56±7.17	NR	<0.001
			Group2: Mulligan bent leg raise+ Conventional treatment	41.93±10.26	18.56±4.58	NR	<0.001
		SLR ROM (degrees)	Group1: NM+ Conventional treatment	67.18±10.94	77.68±7.45	NR	<0.001
			Group2: Mulligan bent leg raise+ Conventional treatment	69.50±10.44	82.93±6.72	NR	<0.001
3	Alshami et al.,	Hip flexion ROM (degrees)	Group1: Slider NM +TENS	58	74	16.7	< 0.001
			Group2: Tensioner NM + TENS	46	69	22.2	< 0.001
			Group3: TENS only	52	58	5.9	> 0.050
		Knee	Group1: Slider NM +TENS	44	63	18.8	< 0.001

		extension ROM (degrees)	Group2: Tensioner + TENS	43	64	21.5	< 0.001
			Group3: TENS only	38	43	5.3	> 0.050
4	Plaza-Manzano et al.,	S-LANSS	Group1: NM+ motor control exercises	12.0 ± 1.1	6.6 ± 0.8	NR	NR
			Group 2: Motor control exercises only	12.0 ± 1.3	9.5 ± 0.9	NR	NR
		RMDQ	Group1: NM+ motor control exercises	11.2 ± 1.5	5.6 ± 1.1	NR	NR
			Group 2: Motor control exercises only	10.5 ± 2.6	6.2 ± 1.2	NR	NR
		SLR (degrees)	Group1: NM+ motor control exercises	55.2 ± 6.5	73.9 ± 10.1	NR	NR
			Group 2: Motor control exercises only	53.2 ± 10.0	62.7 ± 12.7	NR	NR
		PPTs over the tibial nerve (kg/cm2)	Group1: NM+ motor control exercises	3.2 ± 0.6	4.1 ± 0.7	NR	NR
			Group 2: Motor control exercises only	3.4 ± 0.9	4.2 ± 1.0	NR	NR
		PPTs over the common peroneal nerve (kg/cm2)	Group1: NM+ motor control exercises	2.1 ± 0.9	3.0 ± 0.7	NR	NR
			Group 2: Motor control exercises only	2.3 ± 1.0	2.9 ± 0.8	NR	NR
5	Morsi et al.,	ODI	Group1: Slider NDM technique	NR	NR	NR	0.0001
			Group2: Tensioner NDM technique	NR	NR	NR	0.0001
			Group3: Stretching exercise	NR	NR	NR	0.0001
		Ankle dorsiflexion ROM (degrees)	Group1: Slider NDM technique	NR	NR	NR	0.0001
			Group2: Tensioner NDM technique	NR	NR	NR	0.0001
			Group3: Stretching exercise	NR	NR	NR	0.0001
6	Zainab et al.,	MODI	Group1: Sciatic nerve mobilization + routine physical therapy treatment	25.06±6.61	12.15±7.50	NR	0.000
			Group2: Hot pack +back strengthening exercises + abdominal bracing exercises	20.22±5.62	6.39±3.98	NR	<0.0.001
		SLR (degrees)	Group1: Sciatic nerve mobilization + routine physical therapy treatment	46.05±5.50	58.37±5.78	NR	0.040

			Group2: Hot pack +back strengthening exercises + abdominal bracing exercises	49.12±4.78	61.37±6.69	NR	0.011

Abbreviations: MODQ=Modified Oswestry Disability Questionnaire, Lumbar FROM= flexion Range of Motion, VAS= Visual analogue scale, NPRS= Numeric Pain Rating Scale, ODI=Oswestry Disability Index, NM =Neural mobilization, TENS =Transcutaneous electrical nerve stimulation. LSE =Lumbar stabilization exercise, and RESWT =Radial Extracorporeal Shock Wave Therapy, S-LANSS =Self-report Leeds Assessment of Neuropathic Symptoms and Signs Scale, RMDQ = Roland-Morris Disability Questionnaire, PPTs= Pressure Pain Thresholds, MODI= Modified Oswestry Disability Index.

Impact of neural mobilization on pain and other outcome measures

Seven studies reported a statistically significant improvement by using NM ($p \leq 0.05$) in pain and other outcome measures, while one study did not report a p-value (Plaza-Manzano et al., 2020). Moreover, two studies compared two techniques of NM, slider and tensioner NM techniques, and reported statistically significant results (Alshami et al., 2021; Morsi et al., 2021). According to Alshami et al., (2021) the tensioner NM technique is more effective in decreasing pain and increasing hip flexion and knee extension ROM than the slider NM technique, while in Morsi et al., (2021) study, the tensioner and slider technique was used. However, no pre-post data were reported, only reporting that there was a significant improvement in pain, ODI, and ankle dorsiflexion ROM ($p<0.001$).

In terms of the mean difference between groups, only two studies reported pre-post-intervention mean differences within the groups (Alshami et al., 2021; Alatawi, 2019). In both studies, the NM groups showed a greater mean difference than the control groups in pain (NM = 4.67 vs. control = 3.33), lumbar flexion ROM (NM = 4.25 degrees vs. control = 1.25 degrees), and MODQ (NM = 14.05 vs. control = 5.46) in Alatawi's study; and pain (tensioner NM =3 .0 and slider NM = 2.4 vs. control = 1.0), hip flexion ROM (tensioner NM = 22.2 and slider NM = 16.7 degrees vs. control = 5.9 degrees), and knee extension ROM (tensioner NM = 21.5 and slider NM=18.8 degrees vs. control=5.3 degrees) in Alshami's study. The results are reported in (Tables 4 and 5).

4. DISCUSSION

Sciatica pain is considered a major problem for those diagnosed with it, and it impacts their lives significantly, as reported in the literature (Pais et al., 2013; Ribeiro et al., 2018). The present study aimed to systematically review the literature to explore the impact of NM on the sciatica pain identified and reported in the published literature. The participants across all studies included in this review were diagnosed with sciatica pain. Moreover, according to those studies, a wide range of treatment strategies used in combination with NM to manage sciatica pain include hot packs, exercise therapy, and electrotherapy to reduce pain and improve the symptoms associated with sciatica. The studies frequently used several outcome measures, including VAS, NPRS, ODI, and ROM. All outcome measures used have shown decreased pain and symptoms and increased ROM, except in one study that did not report the significance level (Plaza-Manzano et al., 2020).

Only two studies reported pre-post intervention mean differences within the groups Alshami et al., (2021), Alatawi, (2019), and out of eight, only three studies successfully reported the discrete impact of using NM separately to treat sciatica pain and reported significant results (Morsi et al., 2021; Yamin et al., 2016). Pain was measured before and after using NM, and a significant improvement was observed across seven out of eight studies. However, this improvement was significant in both NM and other comparable treatment groups (control groups), i.e. no differences were identified in favor of NM compared to other treatment modalities. Moreover, five studies used different types of exercises, including strengthening, stretching, motor control, and stabilization exercises, to treat sciatica pain and reported significant results. These results are consistent with the literature as exercise is effective in the short term; however, this effect is claimed to be small (Fernandez et al., 2016).

Moreover, two studies used electrical modalities in combination with NM to treat sciatica pain, including RESWT and TENS, and all showed significantly positive results (Alshami et al., 2021; Alatawi, 2019). In terms of the discrete effect of NM, two studies compared the effect of NM with lower back segment stabilization exercises and the Mulligan bent leg raise technique, and one study used NM separately without recruiting a control group Yamin et al., (2016), while five studies combined NM with other treatments in

the same group (Adnan et al., 2022; Alshami et al., 2021; Alatawi, 2019; Plaza-Manzano et al., 2020). Thus, combining NM with other therapeutic modalities in the same treatment group limited the option to conduct a meta-analysis to measure the effect size of NM individually on reducing pain in sciatica patients (Adnan et al., 2022).

Overweight and obesity were reported as risk factors for lumbar radicular pain and sciatica in both men and women with a dose-response relationship, as reported in a meta-analysis published in 2014 (Shiri et al., 2014). This is consistent with the findings of our review, as two of the studies reported that participants' mean BMI fell into the overweight category (25–29.9 kg/m2) (Morsi et al., 2021; Alshami et al., 2021). The mechanism that explains the relationship between obesity and sciatica pain is still unknown. However, the excessive adipose tissues that are associated with obesity can release inflammatory mediators, which might contribute to developing chronic low-grade inflammation and, as a result, might lead to developing sciatica (Berg and Scherer, 2005).

The tensioner and slider are two different techniques of NM that were used in two studies and showed positive results Morsi et al., (2021), Alshami et al., (2021) which was consistent with the literature as both slider and tensioner NM exercises are found to reduce sciatica pain and improve ROM (Alharmoodi et al., 2022; Papacharalambous et al., 2022). With the tensioner technique, NM is obtained by moving one or several joints to elongate the nerve bed, forcing the nerve to slide relative to its surrounding structures. Biomechanical studies have demonstrated that a joint movement that elongates the nerve bed can increase the strain (the ratio of elongation to the original length) in the nervous system, and this cumulative increase in strain occurs if several joint movements are combined.

Alternatively, in the slider technique, at least two joints are moved simultaneously in such a manner that the movement in one joint counterbalances the increase in nerve strain caused by the other movement. Such sliding techniques were designed and implemented on the assumption that they are associated with much larger excursions of the nervous system relative to surrounding structures but without great increases in nerve strain (Coppieters et al., 2015). Combining tensioner and slider NM techniques with stretching exercises improved VAS and ODI significantly Morsi et al., (2021), and combining them with TENS showed a significant decrease in VAS with a mean difference significantly greater when used with the tensioner technique than the slider technique (Alshami et al., 2021). However, using them and comparing the effect of these two techniques separately on sciatica pain have not yet been investigated.

In terms of the methodological quality of the studies, essential data were missing in several studies such as participants' gender in two studies Zainab et al., (2022), Alatawi, (2019), the mean BMI in four studies Zainab et al., (2022), Adnan et al., (2022), Plaza-Manzano et al., (2020), Yamin et al., (2016), and the significance level within the groups before and after receiving the intervention in one study (Plaza-Manzano et al., 2020). These gaps highlight the lack of quality presented in the available literature. Therefore, future studies are urged to focus on following standard guidelines when designing and conducting RCTs, such as the CONSORT statement, which can improve the methodological quality of conducting the studies and reporting the data.

Strengths and limitations

This review had several strengths. To the authors' knowledge, this is the first review that investigated the impact of NM on sciatica pain. All studies were RCTs, and the patients were blinded in 80% of the studies included, which decreases the probability of bias among participants. In terms of limitations, this review pointed out several considerations. First, combining NM with other treatment modalities in five studies and using NM separately to treat sciatica pain in three studies only limited the ability to identify the discrete effect of using NM and isolate it from the other treatment modalities. Moreover, this made conducting a meta-analysis to measure the effect size of NM on sciatica pain not applicable. Second, the studies recruited a relatively small sample size, which might restrict the ability to perform subgroup analyses.

Third, four studies failed to report participants' BMI, which affected the quality of results reported when taking into consideration that being overweight or obese is one of the causes of developing sciatica. Finally, only two studies reported the pre-post intervention mean differences in outcome measures, limiting the ability to compare the mean differences between the subgroups. Therefore, future studies are advised to strictly follow standard guidelines when developing, conducting, and reporting RCTs, emphasizing essential data, including participants' characteristics such as gender and BMI. They are further advised to recruit a relatively larger sample size and use NM as an independent therapeutic modality, comparing it with other modalities instead of combining it with other modalities to allow identification of the discrete effect of NM on pain among patients with sciatica.

5. CONCLUSION

Overall, the studies presented in this review have highlighted the positive impact of NM on sciatica pain by reducing pain. Moreover, NM appears to be an effective intervention in addressing pain and other sciatica symptoms when combined with other interventions in the short term (strengthening exercises, motor control exercises, LSE, stretching exercises, RESWT, and TENS). Therefore, future studies are recommended to identify the discrete effect of NM on sciatica pain in the long term and perhaps perform a sham-controlled comparison to subgroups in RCTs, recruit a larger sample size, and not forget to report gender and BMI in the results and increase the quality of reporting the data by following standard guidelines to increase the methodological quality of the studies.

Acknowledgment

The first author (MZ) would like to thank Dr. Rania Almeheyawi for her invaluable guidance and support throughout this project.

Author contributions

MZ conceived the study design, conducted the research, applied eligibility criteria, extracted data, evaluated the included studies using the CONSORT statement checklist, and wrote the introduction, methods, and results. RA contributed to the study design conception, research conduct, and application of eligibility criteria, as well as wrote the discussion and conclusion. All authors have drafted the manuscript and critically reviewed and approved the final draft.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

This study has not received any external funding.

Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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